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(54) **COOLING STRUCTURE OF A RACK FOR ELECTRONIC DEVICES.**

(57) In a cooling structure of a rack for electronic devices, in which a plurality of shelf units are vertically stacked in a cabinet, each of said shelf units holding a plurality of printed boards and having ventilation holes in the upper and lower surfaces, wherein individual cooling blocks are formed, each provided with a fan unit having at least one fan and mounted on each of the shelf units, the cooling air is made to flow linearly through the shelf units by the fan unit of each cooling block from the lower position toward the higher position, the external air is introduced through ventilation holes formed in the side surfaces of the fan units and is mixed with the cooling air by taking advantage of the flow speed of the cooling air, and the flow rate of the cooling air is gradually increased as it goes toward the upper cooling blocks by the use of the blowing force that is added up as the cooling air flows upward through the fan units.

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DESCRIPTION

TITLE OF THE INVENTION

Cooling Structure of Electronic Equipment Rack

TECHNICAL FIELD

The present invention relates to a cooling structure of an electronic equipment rack which comprises a plurality of shelf units stacked one upon another, each shelf unit including a plurality of printed circuit boards, for electronic equipment such as a communication equipment and an exchange, and particularly to a forced air cooling type cooling structure provided with fans.

BACKGROUND ART

In electronic equipment such as communication equipment, a plurality of printed circuit boards are housed in a shelf unit having a predetermined function, and a plurality of the shelf units are stacked one upon another and arranged in a cabinet or fitted to a frame to constitute a rack having a particular function. The shelf units must be cooled for long term stabilization of the function of respective printed circuit boards housed in each shelf unit. Recently, the thermal density of the printed circuit board and of the shelf unit accommodating the printed circuit boards have been increased with the advance of a high density arrangement of elements on the printed circuit board and high integration of the element itself. For example, the thermal density of a conventional printed circuit board is 10 watts per liter, as indicated by a black dot shown in Fig. 17. On the other hand, the technical development in recent years has brought the power consumption to 1/2 and the volume to 1/4 of those in the conventional printed circuit board to increase the thermal density to 20 watts per liter, which is twice the conventional case, as indicated by a white dot in the figure.

To cool the shelf unit accommodating printed circuit boards exhibiting such a large thermal density,

a forced air cooling type cooling structure provided with fans is used. In this type of cooling structure, an important factor for realizing an effective heat radiation is not only a temperature of the cooling air which passes over the printed circuit board but also a velocity of the cooling air.

Figures 15 and 16 show a prior art cooling structure. In the figures, two shelf units 101 are stacked one upon the other, and a cooling unit 102 is disposed on top of them. The stacked shelf units 101 and cooling unit 102 constitute a cooling block, and a plurality (two in the example shown in Fig. 15) of the cooling blocks are stacked and received in a cabinet (not shown) to constitute a rack 105 as a whole. As shown in Fig. 16, a plurality of printed circuit boards 103 are housed side by side in each shelf unit 101. In the cooling unit 102, four fans (blowers) each blowing frontward are provided. For the two-story shelf units, the fan 104 takes atmosphere in from a bottom of the two-story shelf units, allows the air to pass through the shelf units, and discharges the air from a front door (not shown) of the cabinet through the front of rack 105, as indicated by an arrow A (Fig. 15).

The prior art cooling structure mentioned in the above has the following drawbacks:

(1) A plurality (two in this example) of the shelf units 101 stacked under the fan 104 are cooled by the cooling air which first cools a lower shelf unit, is heated by the lower shelf unit, and then cools an upper shelf unit by passing thereover. As a result, a temperature of the cooling air for cooling the upper shelf unit is higher than that for cooling the lower shelf unit, causing a temperature difference between the upper and lower shelf units. Accordingly, a cooling capacity for the upper shelf unit is lowered. Since an allowable total heating value in each cooling block is set according to a temperature of a shelf unit which

will have a higher temperature (normally, the lower shelf unit), the heating value of the upper shelf unit will be restricted by the temperature difference mentioned above.

(2) If cooling units with fans are provided for respective shelf units to solve the problem mentioned above in (1), the cooling units will occupy a large space in the cabinet and prevent an overall high density arrangement in the cabinet.

(3) A flow of the cooling wind (arrow A) is suddenly changed from a bottom-to-top direction to a lateral (horizontal) direction by a rear slope 102a of the cooling unit 102, and thus the flow resistance become larges and the cooling efficiency is deteriorated.

(4) If a fan in the cooling unit 102 fails, a temperature of a shelf unit located under the cooling unit accommodating the failed fan tends to be increased, and reliability can not be attained.

(5) Since the cooling wind is discharged laterally (horizontally) through the front door of cabinet, the discharged air will give an uncomfortable feeling to maintenance personnel and a loud noise from the fans.

DISCLOSURE OF THE INVENTION

In view of the problems of the prior art cooling structure mentioned above, it is an object of the present invention to provide a cooling structure for an electronic equipment rack, which can effectively cool respective shelf units of the rack and secure a specified wind velocity necessary for the radiation of heat without increasing a height of the rack.

In order to accomplish this object, the present invention provides a cooling structure for an electronic equipment rack which comprises a plurality of shelf units stacked one upon another and arranged in a cabinet, each shelf unit accommodating a plurality of printed circuit boards and having vent holes formed on upper and lower surfaces thereof respectively, wherein a fan unit

having at least a fan is disposed on top of each shelf unit to constitute a separate cooling block, and the fan unit of each cooling block generates a cooling wind which is passed linearly through the shelf unit from the bottom to the top of the shelf unit as well as introducing atmosphere through vent holes formed on side face portions of each fan unit to mix the atmosphere with the cooling wind so that the flow rate of the cooling wind will be gradually increased as the cooling wind proceeds to the upper cooling blocks due to the addition of an upward blowing force caused by the fans of the fan units.

BRIEF DESCRIPTION OF THE DRAWINGS

These and other objects and features of the present invention will become apparent from the following description with reference to the accompanying drawings, in which:

Fig. 1 is a view showing a basic constitution of a cooling structure according to the present invention;

Fig. 2 is a view showing a constitution of an electronic equipment rack provided with the cooling structure according to the present invention;

Fig. 3 is a view showing a constitution of another embodiment of the electronic equipment rack provided with the cooling structure according to the present invention;

Fig. 4 is a perspective view showing a basic constitution of the cooling structure according to the present invention;

Fig. 5 is a cross-sectional view showing a fan unit portion of the structure shown in Fig. 4;

Figs. 6 and 7 are perspective views showing embodiments respectively of the fan unit according to the present invention;

Figs. 8 and 9 are view showing structures according to a prior art and the present invention

respectively for a temperature rise experiment;

Fig. 10 is a graph showing a result of the experiment;

Fig. 11 is a view explaining another experiment for the structure according to the present invention;

Fig. 12 is a graph showing a result of the experiment shown in Fig. 11;

Fig. 13 is a view explaining still another experiment for the structure according to the present invention;

Fig. 14 is a graph showing a result of the experiment shown in Fig. 13;

Fig. 15 is a view explaining the prior art electronic equipment rack;

Fig. 16 is a perspective view showing a part of the prior art rack; and

Fig. 17 is a view explaining the increase of thermal density of a shelf unit.

BEST MODE FOR CARRYING OUT THE INVENTION

Figure 1 shows a basic constitution of the present invention. A fan unit 9 is disposed on top of each shelf unit 1 which houses a plurality (only one is shown) of printed circuit boards 3. The fan unit 9 is provided with vent holes (not shown) formed on upper and lower surfaces of the fan unit 9 to allow a cooling wind to pass. A plurality (only one is shown) of fans 4 are arranged horizontally in the fan unit 9, each fan 4 blowing upward. Each fan 4 is fixed to a support frame 7 which is fixed to a support plate 6 which constitutes a frame of each fan unit 9. Slanted guide portions 6a are provided for front and rear end portions of the support plate 6 to take atmosphere in along arrow marks B from the front (the left side of Fig. 1) and the back (the right side of Fig. 1) of the fan unit 9. The fans 4 of each fan unit 9 such air from a shelf unit 1 located just below the fan unit 9 and send it to a shelf unit 1 located just above the fan unit 9, as indicated

by an arrow mark C, as well as taking atmosphere in along the arrow marks B into the fan unit 9 to send the atmosphere with pressure to the shelf unit 1 located just above the fan unit 9. As mentioned in the above, fan units 9 are assembled with shelf units 1 respectively to constitute cooling blocks respectively. A plurality of the cooling blocks are stacked and received in a cabinet (not shown) to constitute a rack.

Figure 2 shows a constitution of an embodiment of an electronic equipment rack provided with the cooling structure according to the present invention. Two racks 5a and 5b are set on an air passage 46 arranged on the floor such that the backs of racks 5a and 5b face each other. An air passage 47 communicating with the air passage 46 arranged on the floor is formed between the racks 5a and 5b. Front doors 8 having proper vent openings (not shown) for introducing atmosphere are provided at the fronts of racks 5a and 5b. Respective racks 5a and 5b comprise a plurality of stories (five stories in this embodiment) of shelf units 1. On top of each shelf unit 1, there is provided the fan unit 9 having at least one (only one is shown in the figure) fan 4 which is arranged horizontally. Each fan unit 9 sucks air from its lower shelf unit 1 to send the air upward as indicated by an arrow mark C as well as taking in atmosphere from the front and rear faces of the fan unit 1 to send the atmosphere to its upper shelf unit with pressure as indicated by arrow marks B_1 and B_2. Namely, cooling air is introduced from the air passage 46 arranged on the floor into the lowest shelf unit, passed successively and linearly through the upper shelf units as indicated by the arrow mark C, and discharged from the top surface of the uppermost shelf unit. At the same time, atmosphere is introduced at each of the shelf units as indicated by the arrow marks B_1 and B_2. As the cooling air indicated by the arrow mark C proceeds to upper shelf units, the cooling air is heated by the

shelf units and the temperature of the cooling air will be continuously increased. The cooling air, however, is cooled by the atmosphere which is introduced at each of the shelf units as indicated by the arrow marks B_1 and B_2 so that the temperature increase of the cooling air in the upper shelf units will be suppressed to a relatively small magnitude. Further, the rate and velocity of airflow is increased successively toward the upper shelf units, because the atmosphere is introduced at each of the shelf units. As a result, the heat radiating effects of the upper shelf units are increased so that a cooling effect necessary for maintaining a stable shelf function will be achieved even if the temperature of cooling air is increased by a certain degree. The cooling air is discharged upward but not frontward after passing through the shelf units so that maintenance personnel standing in front of the rack will not be given an unpleasant feeling, and noise due to the rotation of fans will be suppressed to a low level. Since the fans are arranged horizontally with their blowing directions upward, the facility installation space will be used efficiently and with a high density. Since each shelf unit is provided on top with a fan unit, each shelf unit may have two fan units on upper and lower sides thereof respectively. Therefore, even if one fan fails and stops, a forced convection action of the cooling air will be effected with almost no hindrance so that the reliability of the cooling action will be increased. Further, a ventilation action is smoothly carried out even if the thicknesses of printed circuit boards and the pitches of printed circuit board array are different in an upper and a lower shelf units so that the degree of freedom in mounting the printed boards will be increased. For a shelf unit in which a heating value is smaller, a fan unit to be located just above the shelf unit may be omitted.

Figure 3 shows a constitution of another embodiment

of the rack which is provided with the cooling structure according to the present invention. In this embodiment, fan units are not provided for the uppermost shelf units 1a of the racks 5a and 5b. Instead, guide plates 49 are provided on top of the uppermost shelf units 1a to guide the heated discharge air toward the center air passage 47 to prevent the heated air from being discharged from the upper surfaces of the uppermost shelf units 1a. This arrangement is required to protect cables against the heat of discharged air when the cables are arranged in uppermost spaces 40 of the racks 5a and 5b. The other constitution, action, and effect of this embodiment are the same as those of the embodiment shown in Fig. 2.

Figure 4 shows an appearance of an embodiment of the fan unit 9. A shelf unit 1 houses a plurality of printed circuit boards 3 which are arranged vertically in the shelf unit 1. The fan unit 9 disposed on the shelf unit 1 comprises a unit frame 10 comprising side frames 10a and cross frames 10b, and four fans 4 which are arranged horizontally. Each cross frame 10b has a cross-section of substantially a triangular shape as shown in Fig. 5, and is provided with a plurality of intake ports 11 formed on a front surface for taking atmosphere in, vent holes 12 formed on an upper surface, and slanted guide portions 13 provided on a lower surface for guiding atmosphere upward (indicated by arrow marks B_1 and B_2) and for guiding air from a lower side to the fans 4 (an arrow mark C). Each fan 4 is fixed to the cross frames 10b through a frame 4a by proper means such as screws.

Figure 6 is a perspective view showing another embodiment of the fan unit 9. In this embodiment, front and rear support frames 15 each comprising intake ports 11, vent holes 12, and slanted guide portions 13, and a fan 4 are integrally formed in advance to constitute a separate cassette type fan 14. The cassette type

fan 14 is mounted on a unit frame 10 from the front thereof as indicated by an arrow mark D. By adopting such a cassette type structure, the fitting and removing operation of the fan unit can be easily carried out to improve the workability of a replacement work.

Figure 7 shows another embodiment of the cassette type fan. In this embodiment, a support plate 6 having slanted guide portions 6a which have cross-sections shown in Fig. 1 is fixed to a unit frame 10. Along guide rails 24 of the support plate 6, side pieces 22 of a cassette type fan 14 are slid to insert the cassette into a unit 9 from the front thereof as indicated by an arrow mark D. The support plate 6 is provided with a hole 23 at a position corresponding to the fan 4. The numeral 25 represents a means for fixing the cassette. The cassette fixing means 25 may be a mechanical means in which a projection formed on the cassette is held and fixed between two rollers which are engaged with each other by spring means, or may be a magnetic means. The cassette type fan 14 comprises a front panel 20 having atmosphere intake ports 11, a pulling thumbscrew 17, a connector 19 for supplying electric power, a printed circuit board 18, etc., and the fan 4, which are fixed together to a support frame 21.

Figures 8 to 10 explain an experiment carried out to check a temperature rise of the constitution according to the present invention.

In Figs. 8 and 9, the marks S_1 and S_2 represent shelf units positioned in a first story and a second story respectively; and the marks P6, P8, P16, P19, and P20 printed circuit boards and their ordering numbers. For instance, the mark P6 indicates a printed circuit board arranged in a sixth column from the left facing the shelf unit; P8 a printed circuit board in an eighth column; and so on. The numeral 102 represents a prior art fan unit; 104 a fan of the prior art fan unit 9 a fan unit of the present invention; and 4 a fan of

the fan unit of the present invention. The experiment has been carried out subject to a total power consumption (power supply), individual power consumption and heating distribution of each printed circuit board, and the blowing rate of a fan unit of the prior art example (Fig. 8) that are the same as those of the present embodiment (Fig. 9). Under these conditions, ambient temperatures on respective printed circuit boards have been measured to obtain experimental values shown in Fig. 10.

In Fig. 10, temperature rises (°C) are plotted on an axis of ordinate, and measuring points on an axis of abscissa. Black dots represent measured values for the prior art, and white dots measured values for the present invention. As apparent from the figure, values of the temperature rise in the first shelf unit S_1 of the prior art are extremely large in comparison with those of the present invention. Due to this, the power consumption (power supply) of the prior art is restricted. On the contrary, values of the temperature rise of the present invention are small so that the power consumption (power supply) can be increased in the present invention. Namely, an allowable heating value for the present invention can be increased. In the second shelf unit S_2, values of the temperature rise of the present invention are smaller on the whole than those of the prior art. According to the embodiment of the present invention, another fan unit will be actually disposed on top of the shelf unit S_2. Therefore, the cooling effect of the structure according to the present invention will be further increased in practice.

Figures 11 and 12 explain measured values of the temperature rise in a rack equipment 60 according to the present invention. Figure 11 is a front view showing the rack equipment 60 in which values (W) of the power consumption of respective shelf units (30-1 to 30-5) are shown. Figure 12 shows measured values of the tempera-

ture rise in respective shelf units (30-1 to 30-5) shown in Fig. 11.

In Fig. 11, the power consumption is 620 W (45 W max. per printed circuit board) for each of the shelf units 30-1 to 30-4, 312 W (13 W max, per printed circuit board) for the shelf unit 30-5, and 2792 W in total. With respect to the power consumption, the maximum temperatures have been measured for respective shelf units 30-1 to 30-5, and the values shown in Fig. 12 have been obtained.

In Fig. 12, an axis of ordinate represents values (°C) of the temperature rise, and an axis of abscissa the shelf unit numbers (30-1 to 30-5) to plot measured values on the coordinates. In the figure, a value 25°C (the hatched portion in the figure) of the temperature rise indicates an allowable value (a design criterion) to secure the reliability of heating elements. As shown in the figure, the temperature increases gradually from the lowest shelf unit toward the upper shelf units in the shelf units 30-1 to 30-5, and, in the uppermost shelf unit 30-5, the temperature rise is suppressed to 25°C so that a temperature difference between a certain shelf unit and a shelf unit just below the certain shelf unit will be small. By using the cooling structure having such values of the temperature rise, the total electric power of 2792 W can be cunsumed. This power consumption is about twice that of the prior art cooling structure.

A result of an experiment to check wind velocities in the structure according to the present invention will be described with reference to Figs. 13 and 14. A rack 5 used in the experiment comprises shelf units 1 stacked in four stories and fan units 9 which are disposed on top of each of the shelf units 1 as shown in the left side of Fig. 14. Each fan unit 9 is provided with four fans (00 to 03 for the first story, 10 to 13 for the second story, and so on). Each shelf unit 1

houses 32 printed circuit boards 3. The nineteenth printed circuit boards from the left have been measured for wind velocities at positions A to L as shown in Fig. 13. The numeral 26 represents electronic parts mounted on the printed circuit board. The position of each of the measured printed circuit boards is nearly below each of the third fans (02, 12, 22, and 32) from the left in each story. In Fig. 14, the graph showing a result of the measurement corresponds to the four-story rack shown on the left of the figure. In each shelf unit, results of a normal operation of fans (indicated by continuous polygonal lines) and results of an operation with one of fans being stopped (indicated by dotted polygonal lines) are shown. Numerals shown on the right side of the graph represent averages of measured values. As will be seen in the graph, the higher the story of a shelf unit, the higher the wind velocity for the shelf unit. Accordingly, the heat radiation is effectively performed to realize a cooling action which is necessary for maintaining the stability of an equipment function, even if the temperature of cooling air is increased.

CAPABILITY OF EXPLOITATION IN INDUSTRY

The present invention is applicable to the electronic equipment industry in which communication equipment, exchange equipment, etc., are constituted by racks which comprise shelf units each accommodating printed circuit boards.

CLAIMS

1. A cooling structure of an electronic equipment rack which comprises a plurality of shelf units stacked one upon another and arranged in a cabinet each shelf unit accommodating a plurality of printed circuit boards and provided with vent holes formed on upper and lower face portions thereof respectively, said cooling structure comprising:

fan units each having at least one fan, said fan units being disposed on the tops of said shelf units respectively to constitute separate cooling blocks, wherein,

in each of said separate cooling blocks, said fan of said fan unit generates a cooling wind which is linearly passed through said shelf unit from the bottom to the top thereof as well as introducing atmosphere through vent holes formed on side portions of said fan unit by utilizing the flow speed of said cooling wind to mix the atmosphere with said cooling wind, such that, in said rack on the whole, the flow rate of said cooling wind will be gradually increased as the cooling wind proceeds toward the upper cooling blocks from the lowest cooling block by the addition of upward blowing forces caused by said fans of said fan units.

2. A cooling structure of an electronic equipment rack as claimed in claim 1, wherein each of said fans is constituted as a cassette type fan which can be inserted into and removed from a frame of said fan unit from the front of said frame.

3. A cooling structure of an electronic equipment rack as claimed in claim 2, wherein said frame of said fan unit has a support plate having slanted guide portions in common to said cassette type fans to introduce atmosphere, said cassette type fans being mounted on said support plate.

4. A cooling structure of an electronic equipment

rack as claimed in claim 3, wherein said support plate has guide rails for inserting said cassette type fans, and means for fixing and holding said cassette type fans.

5. A cooling structure of an electronic equipment rack as claimed in claim 1, wherein a discharge guide plate is arranged instead of the fan unit for the uppermost shelf unit, said discharge guide plate guiding the cooling air passed through the rack in directions other than the direction toward the top surface of said uppermost shelf unit.

6. A cooling structure of an electronic equipment rack as claimed in claim 1, wherein a fan unit on a certain shelf unit may be omitted depending on the heating value of said certain shelf unit.

AMENDED CLAIMS

1. A cooling structure of an electronic equipment rack which comprises a plurality of shelf units stacked one upon another and arranged in a cabinet each shelf unit accommodating a plurality of printed circuit boards and provided with vent holes formed on upper and lower face portions thereof respectively, said cooling structure comprising:

fan units each having at least one fan, said fan units being disposed on the tops of said shelf units respectively to constitute separate cooling blocks, wherein,

in each of said separate cooling blocks, said fan of said fan unit generates a cooling wind which is linearly passed through said shelf unit from the bottom to the top thereof as well as introducing atmosphere through vent holes formed on said fan unit by utilizing the flow speed of said cooling wind to mix the atmosphere with said cooling wind, such that, in said rack on the whole, the flow rate of said cooling wind will be gradually increased as the cooling wind proceeds toward the upper cooling blocks from the lowest cooling block by the addition of upward blowing forces caused by said fans of said fan units.

2. A cooling structure of an electronic equipment rack as claimed in claim 1, wherein each of said fans is constituted as a cassette type fan which comprises intake holes for introducing fresh air and can be individually inserted into and removed from a frame of said fan unit from the front of said frame.

3. A cooling structure of an electronic equipment rack as claimed in claim 2, wherein said frame of said fan unit has a support plate having slanted guide portions in common to said cassette type fans to introduce atmosphere, said cassette type fans being mounted on said support plate.

4. A cooling structure of an electronic equipment

rack as claimed in claim 3, wherein said support plate has guide rails for individually inserting each of said cassette type fans, and automatic lock means for said cassette type fans.

5. A cooling structure of an electronic equipment rack as claimed in claim 1, wherein a discharge guide plate is arranged instead of the fan unit for the uppermost shelf unit, said discharge guide plate guiding the cooling air passed through the rack in directions other than the direction toward the top surface of said uppermost shelf unit.

6. A cooling structure of an electronic equipment rack as claimed in claim 1, wherein a fan unit on a certain shelf unit may be omitted depending on the heating value of said certain shelf unit.

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Fig. 1

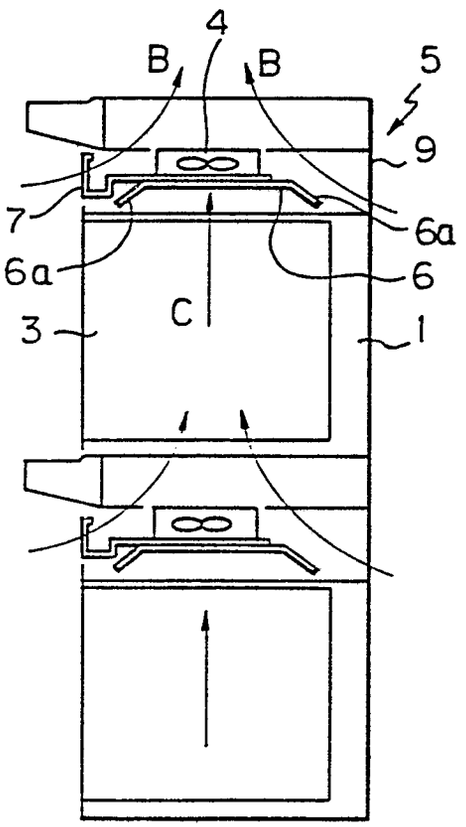


Fig. 2

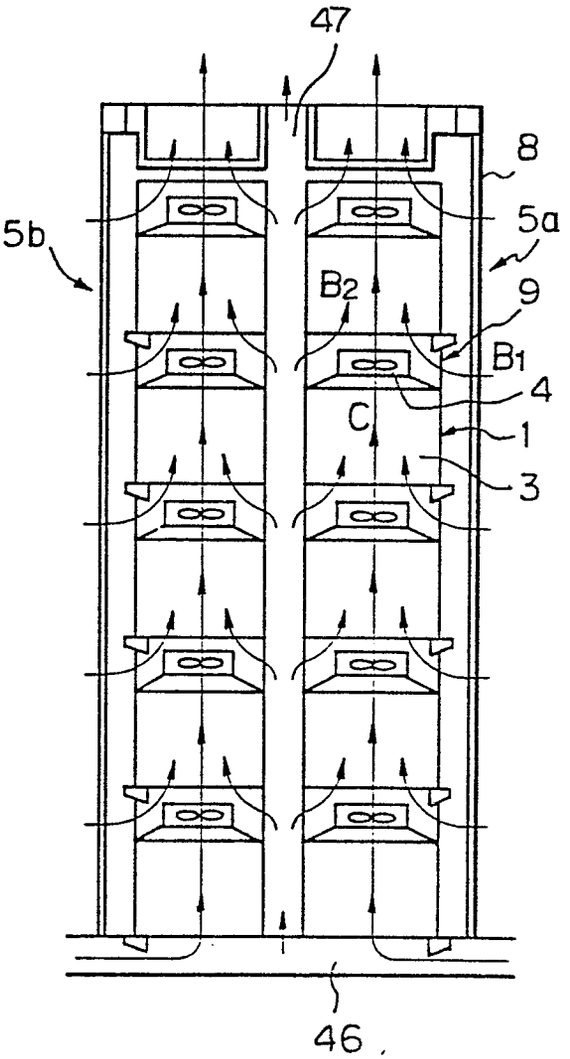
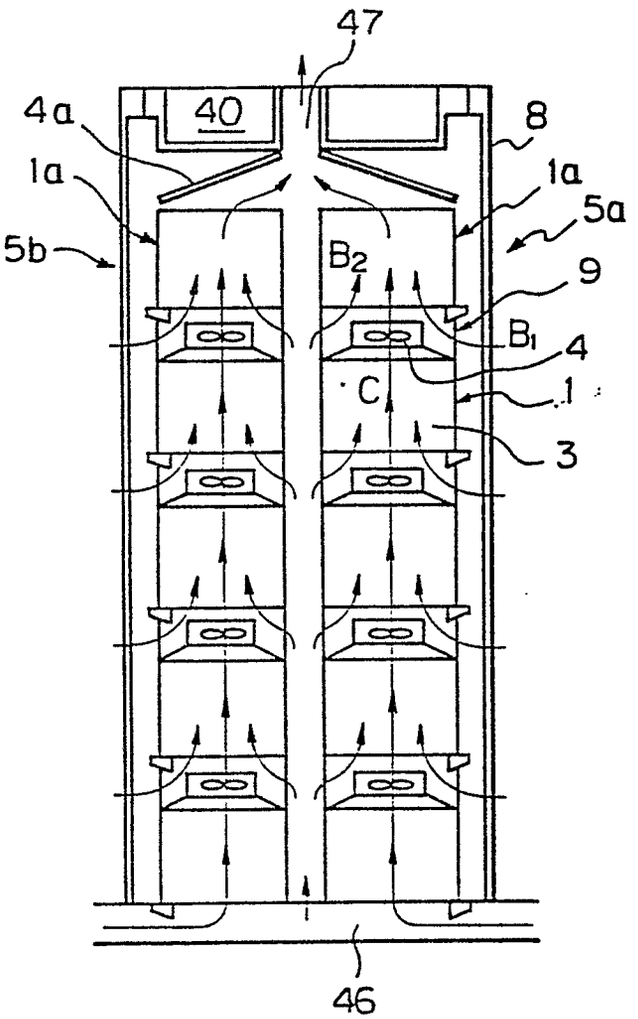


Fig. 3



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Fig. 4

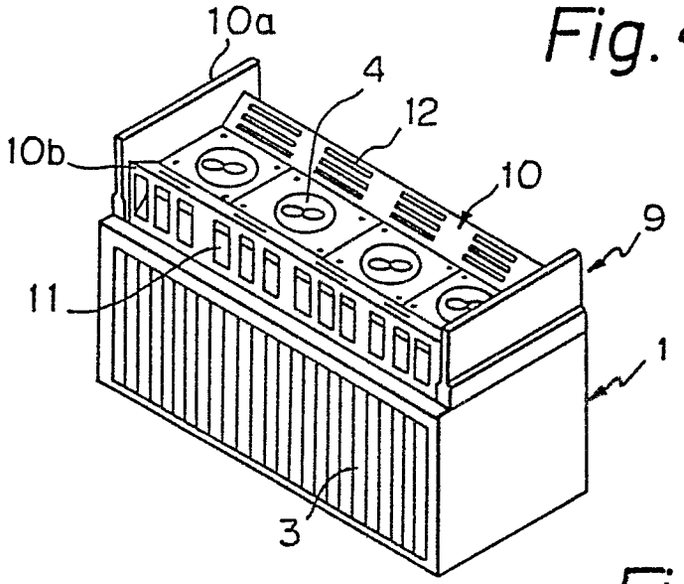


Fig. 5

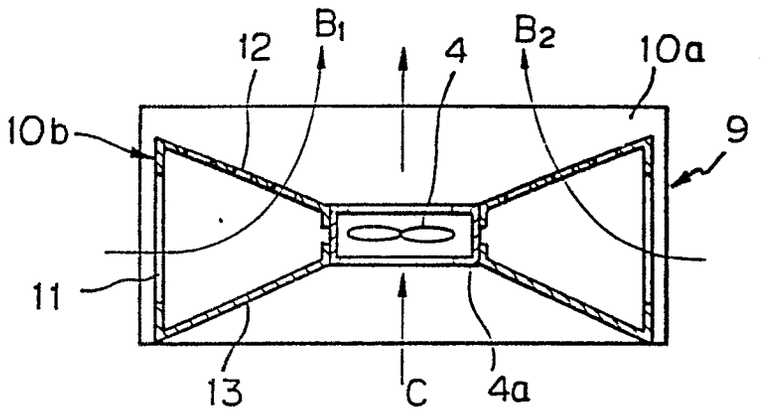


Fig. 6

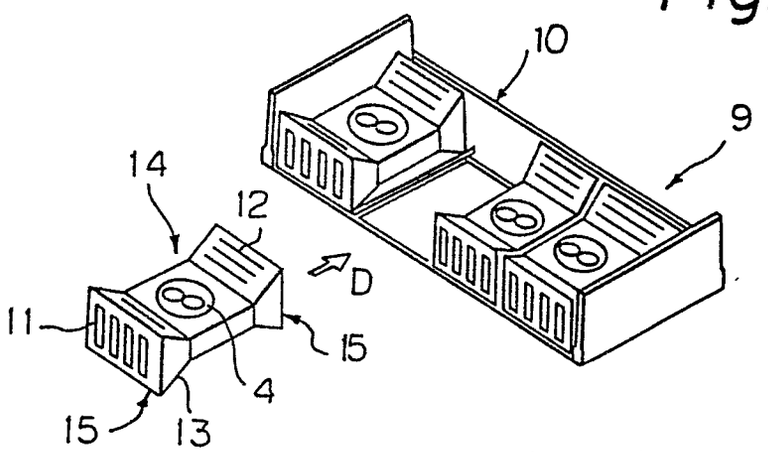
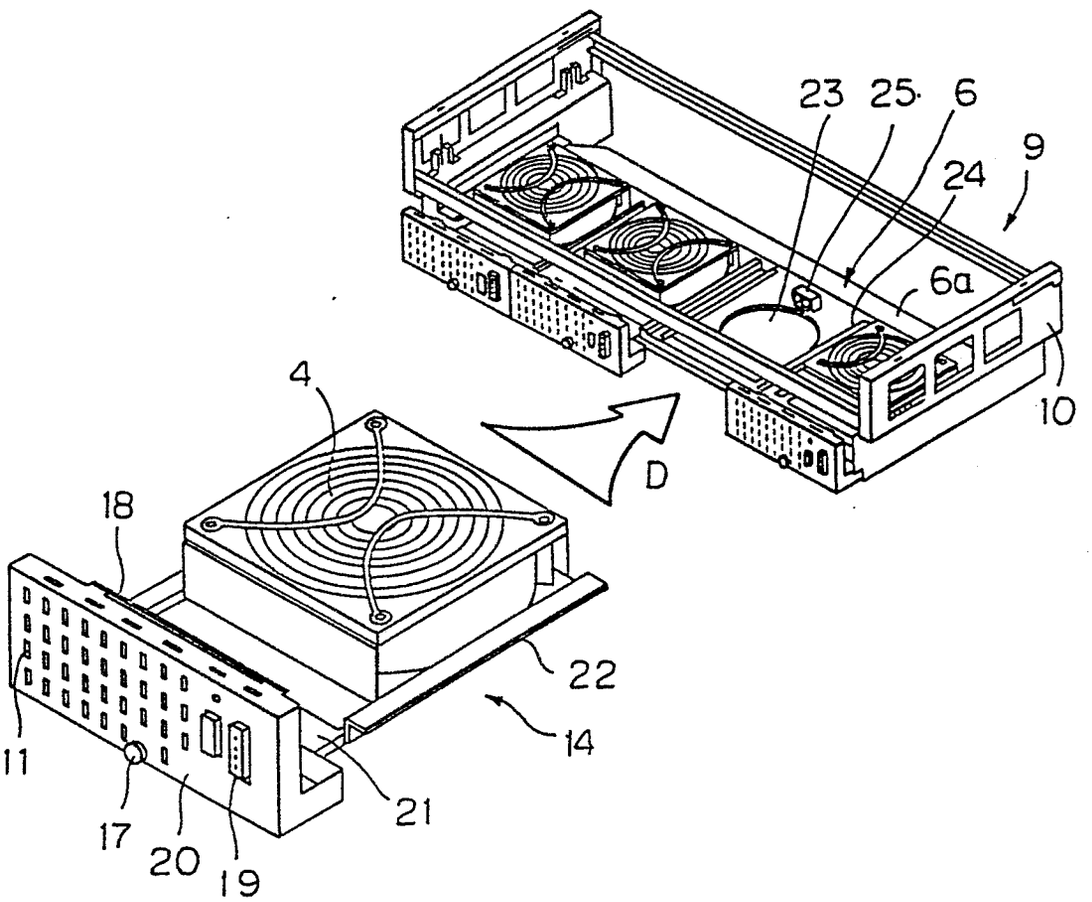


Fig. 7



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Fig. 8

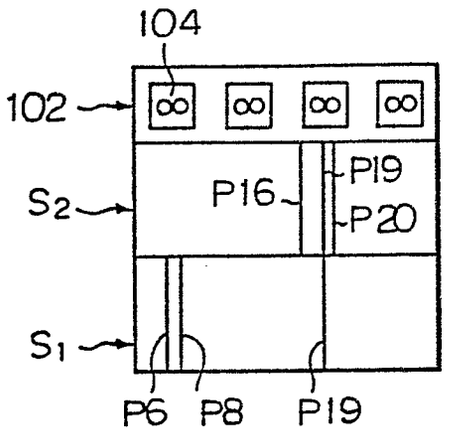


Fig. 9

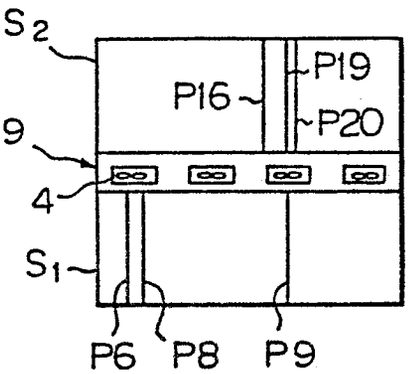
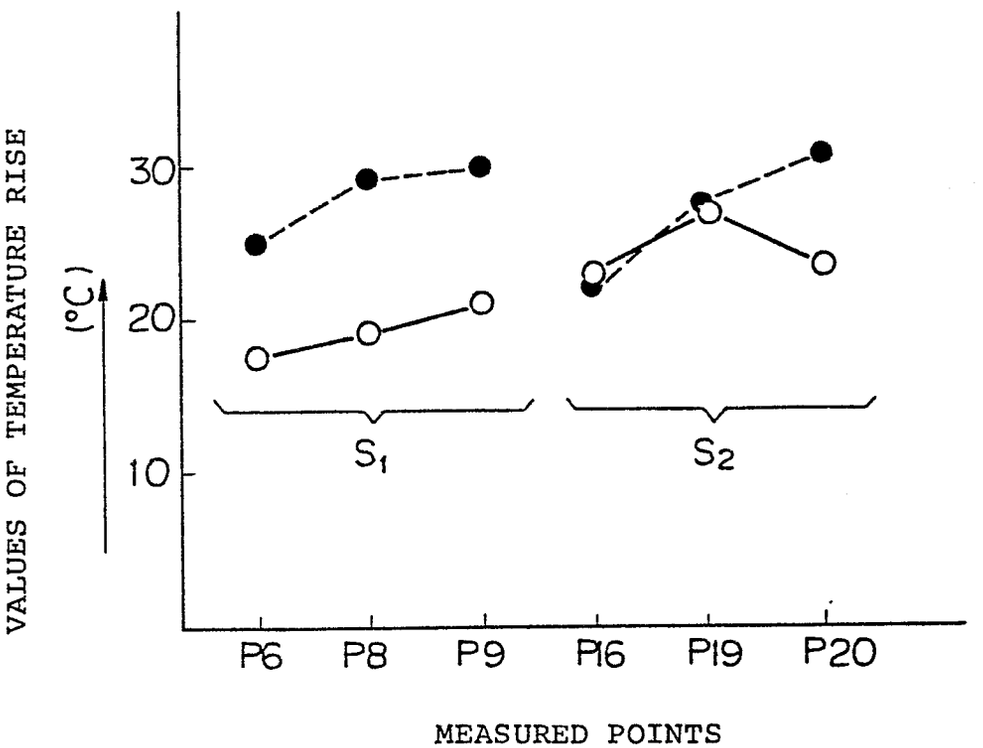


Fig. 10



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Fig. 11

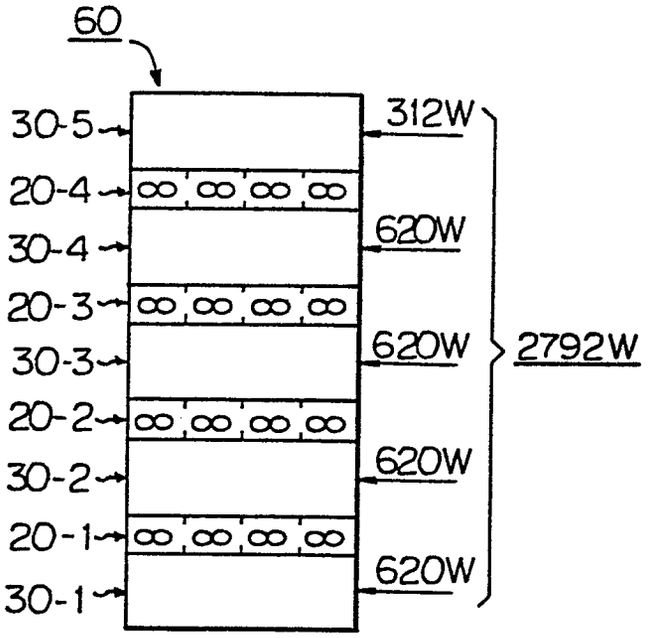


Fig. 12

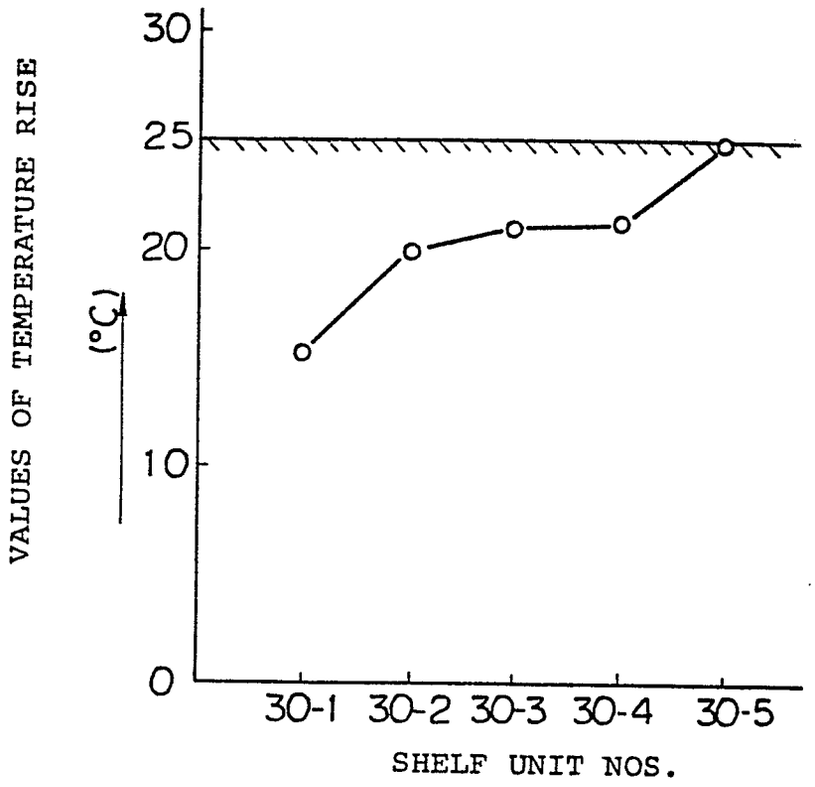


Fig. 13

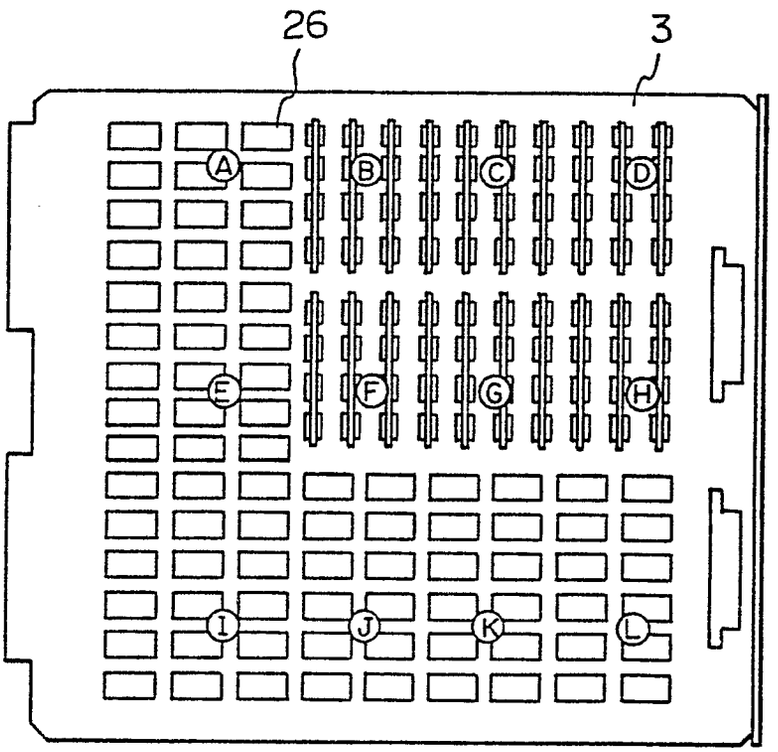
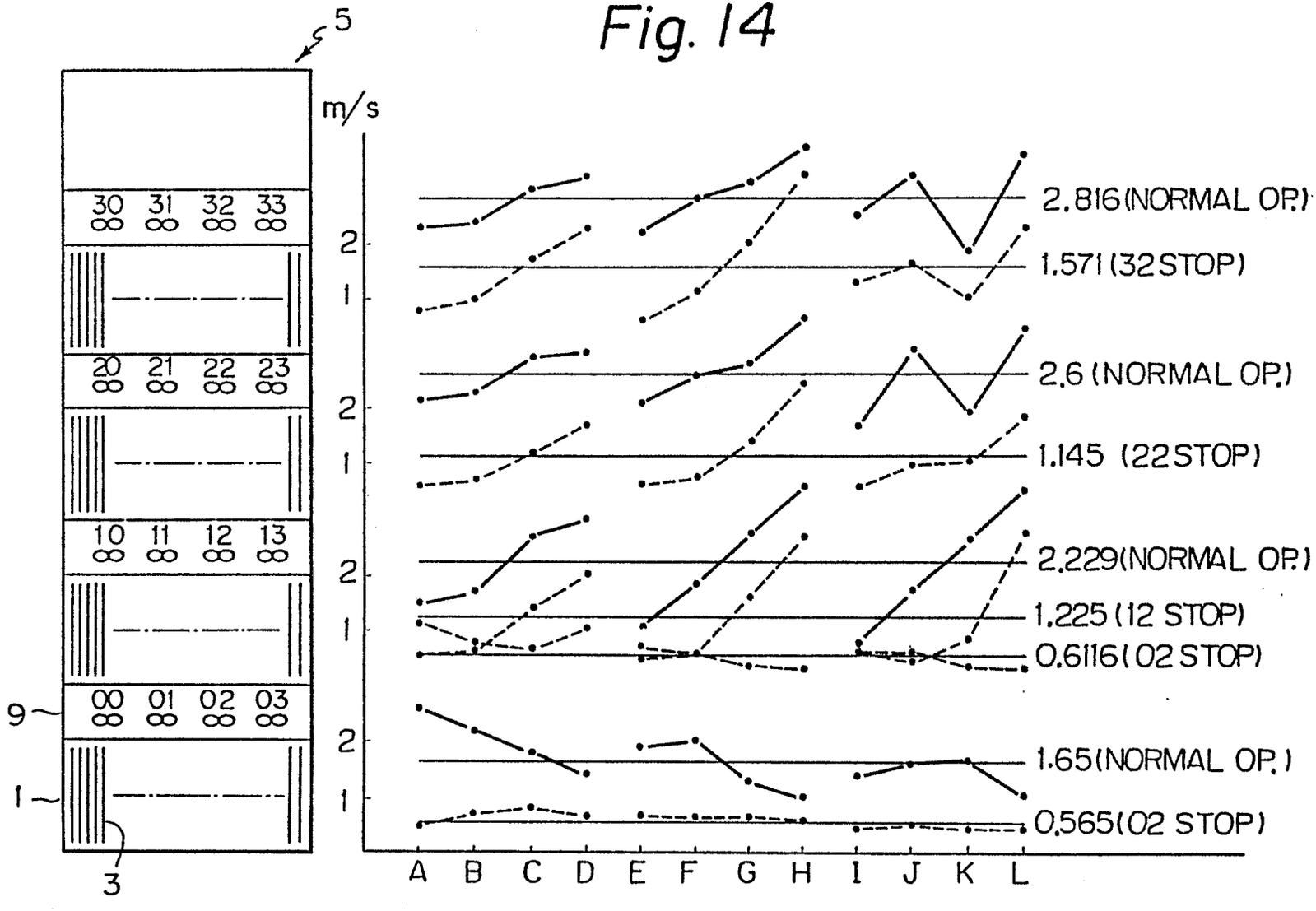


Fig. 14



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Fig. 15

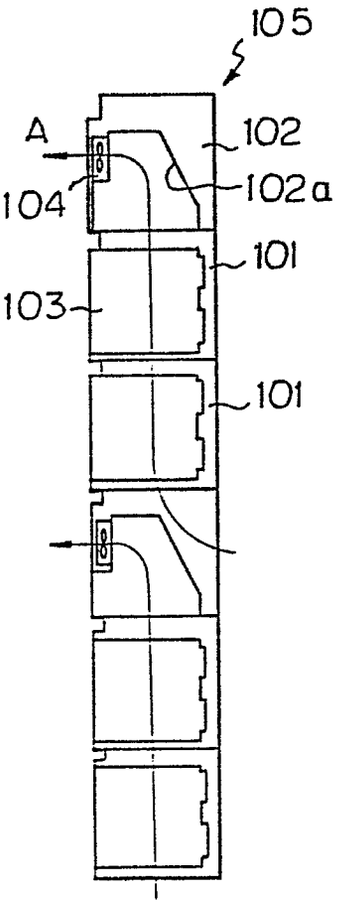


Fig. 16

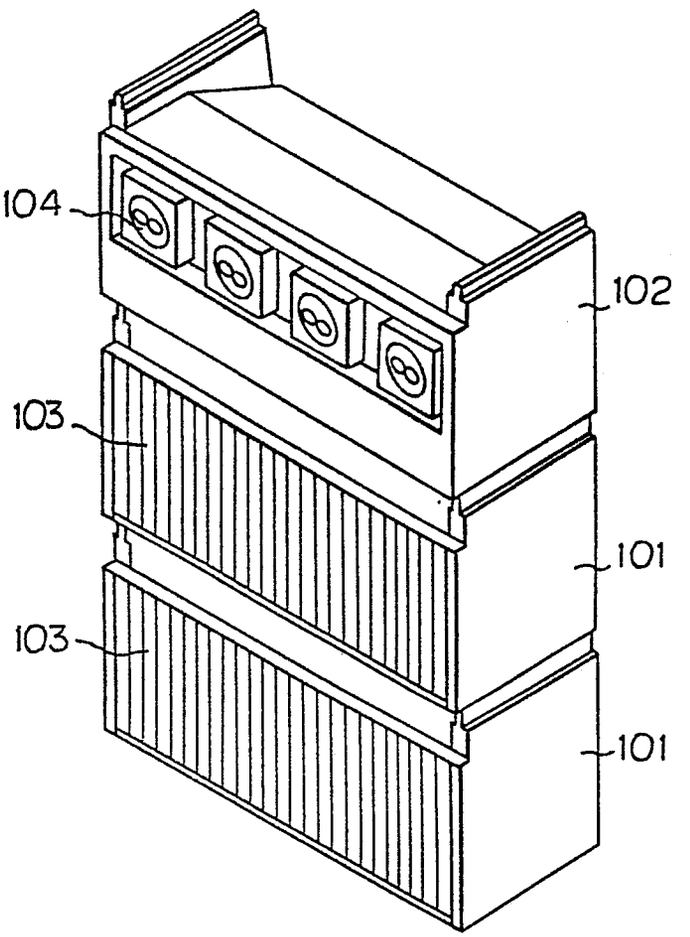
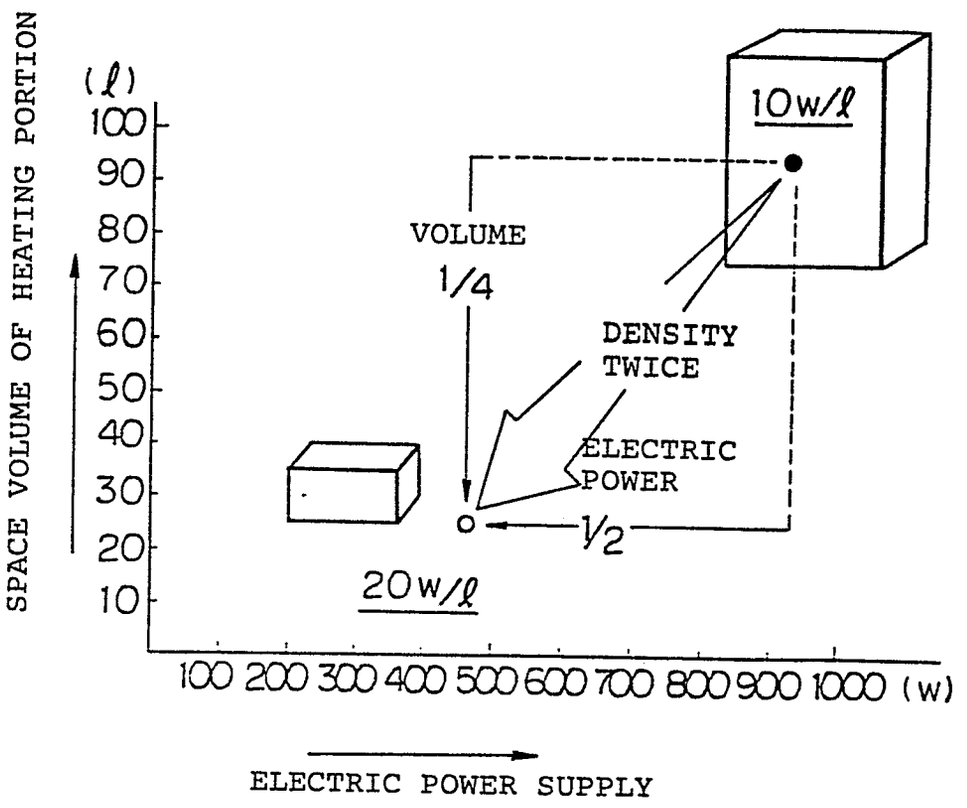


Fig. 17


SPACE VOLUME OF HEATING PORTION
(ℓ)
100
90
80
70
60
50
40
30
20
10
10w/ℓ
VOLUME
1/4
DENSITY
TWICE
ELECTRIC
POWER
1/2
20w/ℓ
100 200 300 400 500 600 700 800 900 1000 (w)
ELECTRIC POWER SUPPLY

INTERNATIONAL SEARCH REPORT

International Application No. PCT/JP85/00236501

I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) [3]

According to International Patent Classification (IPC) or to both National Classification and IPC

Int.Cl[4] H05K 7/20

II. FIELDS SEARCHED

Minimum Documentation Searched [4]

Classification System	Classification Symbols
IPC	H05K 7/20

Documentation Searched other than Minimum Documentation to the Extent that such Documents are Included in the Fields Searched [5]

Jitsuyo Shinan Koho 1926 - 1985
Kokai Jitsuyo Shinan Koho 1971 - 1985

III. DOCUMENTS CONSIDERED TO BE RELEVANT [14]

Category*	Citation of Document, [16] with indication, where appropriate, of the relevant passages [17]	Relevant to Claim No. [18]
Y	JP, A, 60-132395 (Sanyo Electric Co., Ltd.), 15 July 1985 (15. 07. 85) Column 4, lines 8 to 19 (Family: none)	1
Y	JP, U, 57-6296 (Oki Electric Industry Co., Ltd.), 13 January 1982 (13. 01. 82) Column 1, lines 8 to 21 (Family: none)	2, 4
Y	JP, Y2, 55-27279 (Hitachi, Ltd.), 30 June 1980 (30. 06. 80) Column 2, line 33 to column 3, line 6 (Family: none)	1
Y	JP, B2, 56-2439 (Nippon Telegraph & Telephone Public Corp.), 20 January 1981 (20. 01. 81) Column 5, line 38 to column 6, line 3 (Family: none)	1

* Special categories of cited documents: [15]

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"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

IV. CERTIFICATION

Date of the Actual Completion of the International Search [2]	Date of Mailing of this International Search Report [2]
January 10, 1986 (10. 01. 86)	January 20, 1986 (20. 01. 86)
International Searching Authority [1]	**Signature of Authorized Officer [20]**
Japanese Patent Office	